Alignment to the PA STEELS Standards

The mySci *Using Our Resources Wisely* unit was designed for the Next Generation Science Standards (NGSS) and throughout the unit there are indications of NGSS Performance Expectations. The unit is also aligned to the Pennsylvania Science, Technology & Engineering, Environmental Literacy and Sustainability (STEELS) Standards[1]. The targeted performance expectations for this unit from both the NGSS and STEELS standards are shown in the tables below.

STEELS Performance Expectations Addressed	
3.3.4.D Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	3.3.5.D Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

STEELS Performance Expectations Partially Addressed	
3.3.5.E Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	3.4.3-5.A Analyze how living organisms, including humans, affect the environment in which they live, and how their environment affects them.**
3.5.3-5.M Demonstrate essential skills of the engineering design process.*	3.3.5.C Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
3.5.3-5.P Evaluate the strengths and weakness of existing design solutions including their own solutions.*	3.2.4.B Make and communicate observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

*The PA Technology and Engineering standard is partially aligned to the claimed NGSS ETS performance expectation for this unit.
** The PA Environmental Literacy and Sustainability standard is partially aligned to the claimed NGSS ESS performance expectation for this unit.

Color Coding for the Three Dimensions

The mySci *Using Our Resources Wisely* unit uses NGSS color coding to indicate specific connections to each of the three dimensions. The PA STEELS standards use different colors for the three dimensions. The colors used in both standards to refer to the three dimensions are below.

Color coding used for the three dimensions of the NGSS standards	**Color coding used for the three dimensions of the STEELS standards**
Orange text highlights connections to DCIs (**Disciplinary Core Ideas**)	**Blue text** highlights connections to DCIs (**Disciplinary Core Ideas**)
Blue text highlights connections to the SEPs (**Science and Engineering Practices**)	**Green text** highlights connections to the SEPs (**Science and Engineering Practices**)
Green text highlights connections to the CCCs (**Cross-Cutting Concepts**)	**Purple text** highlights connections to the CCCs (**Cross-Cutting Concepts**)

[1] Alignment is based on mySci's NGSS claims and not an in-depth evaluation for STEELS standards.

The purpose of this unit is not to be used in a PA classroom, but rather to illustrate the shifts required by STEELS. With strong science, engineering, and environment connections, it represents the integrated nature of the Pennsylvania STEELS standards while showcasing strong curriculum-based system of assessments.

inspiring the next generation of scientists

Earth and Space Systems:
Natural Resources, Earth Systems, Renewable and Non-Renewable Energy, Human Impacts

Teacher Guide

mySci **Unit 22**:

Using Our Resources Wisely

Washington University in St. Louis
Institute for School Partnership

Bayer Fund

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Table of Contents

mySci Symbols Key		
Indicates an opportunity for students to write	Indicates an opportunity for assessment	Indicates an opportunity to employ a driving question board
Indicates an opportunity for the teacher to make a chart	Indicates an opportunity to attend to equity and inclusion	Indicates appropriate time to administer the post assessment
Indicates an opportunity for reading	Indicates an opportunity to differentiate instruction	Indicates link to a teacher facing mySci tutorial explaining how to set up the activity for students
Indicates an opportunity for discourse	Indicates a key science idea	Indicates a multimedia resource

Using Our Resources Wisely

ANCHORING PROBLEM:

We need farms to grow food, but the process of producing food for all of us can harm Earth systems.

DRIVING QUESTIONS:

How are farms part of Earth's systems?
How does our use of natural resources on farms affect Earth's systems?
How can farmers use resources wisely to protect Earth's systems?

These questions are provided for you as model driving questions to support categorizing individual student questions and organize the learning progression. Each section is designed to intentionally build toward defining the anchoring problem and designing a solution. You can use these questions to guide your instruction, however, you are encouraged to adapt these questions using the language you develop with your students.

Throughout mySci Units color coding is used to call out specific connections to each of the 3 dimensions of the NGSS standards: **Orange text** highlights connections to DCIs (Disciplinary Core Ideas) **Blue text** highlights connections to the SEPs (Science and Engineering Practices) **Green text** highlights connections to the CCCs (Cross-Cutting Concepts)	**STORYLINE** In this unit, students will **make sense of Earth's systems and natural resources, ways that humans use natural resources, human impacts on Earth systems, and how humans can change behaviors to reduce impacts on the environment.** This unit **intentionally develops the Crosscutting Concept of System and System Models and also uses Scale, Proportion, and Quantity and Energy and Matter for sensemaking**. This unit **intentionally develops the Science and Engineering Practices of Developing and Using Models and Obtaining, Evaluating, and Communicating Information.** The unit also **incorporates Using Mathematical and Computational Thinking, Constructing Explanations and Designing Solutions, and Planning and Carrying Out Investigations for sensemaking.** 1. First, students will explore the four Earth systems (hydrosphere, biosphere, atmosphere, and geosphere) and learn how these systems interact. 2. Next, students will learn about natural resources and how humans use them for things like energy, food, and shelter. They will investigate some of the impacts of using natural resources, including the effects of fossil fuel consumption. Students will also examine the hydrosphere in detail, including the distribution of water on Earth. They will learn that water is a limited resource, and the amount and quality of available water can be affected by human activities. 3. Finally, they will learn about strategies humans can use to decrease our impact on the environment. They will examine a case study of an island in Denmark that changed from using non-renewable to renewable energies and then engage in a design challenge to design, build, test, and refine a wind turbine to perform a specific task. Students will also consider how farms can repurpose animal waste to generate energy using biodigesters.

Unit 22: Sections Quick View

Section 1 **How are farms part of Earth's systems?**	Section 2 **How does our use of natural resources on farms affect Earth's systems?**	Section 3 **How can farmers use resources wisely to protect Earth's systems?**
Total time: 6 days LESSON 1 **How can we describe the different parts of the Earth?** *(3 days)* LESSON 2 **How do Earth's systems interact?** *(3 days)*	*Total time: 11 days* LESSON 3 **What are natural resources and how do humans use them?** *(3 days)* LESSON 4 **How does our use of fossil fuels affect Earth's systems?** *(3 days)* LESSON 5 **How does our use of water affect Earth's systems?** *(3 days)* LESSON 6 **How does animal waste affect the environment, and what can we do about it?** *(2 days)*	*Total time: 9 days* LESSON 7 **How can people use resources in a way that is less harmful to the Earth?** *(3 days)* LESSON 8 **How can we use farms to harness wind energy?** *(3 days)* LESSON 9 **How can farms make better use of animal waste?** *(3 days)*

Links to Resources for this Unit

SECTION 1 SLIDE DECK **SECTION 2 SLIDE DECK**

SECTION 3 SLIDE DECK

PARENT/GUARDIAN LETTER

English Version Spanish Version

STUDENT JOURNAL:

Digital Student Journal Answer Key

Print Student Journal Answer Key

ASSESSMENT DOCS:

Post Assessment Answer Key

LITERACY LINKS:

Epic Booklist Unit 22

Quizlet Unit 22

Printable Glossary

Google Slide Vocabulary Cards English

Google Slide Vocabulary Cards English/Spanish

APPENDICES:

Teacher Background Information: Appendix A

Read-Aloud Guides: Appendix B

Handouts/Teacher Pages: Appendix C

NGSS/MLS: Appendix D

Safety Guidelines: Appendix E

Performance Expectations Addressed

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
3-5-ETS1- 3. (5.ETS1.C.1) Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
5-ESS2-2. (5.ESS2.C.1) Describe and graph the amounts of saltwater and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

Performance Expectations Partially Addressed

5-ESS3-1. (5.ESS3.C.1) Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
3-5-ETS1- 2. (5.ETS1.B.1) Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
5-ESS2-1. (5.ESS2.A.1) Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
4-PS3-2.(4.PS3.B.1) Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Unit 22: **Fast Track** Pacing Guide

Unit 22 Fast Track Pacing Guide

These suggestions can be used if you do not have the full amount of time required to dedicate to the whole unit.

Lesson	How to Adapt
Lesson 1	- Explore: Omit going outside.. - Elaborate: Only show one video, or shorten the length of each video. - Elaborate: Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 2	- Explore: Use the virtual adaptation of the activity to reduce setup time. - Explain: Omit the Crash Course Kids videos. - Elaborate: Only show one video, or shorten the length of each video. Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 3	- Explore: Omit comparing and sorting the self-documentation data, and only do the class chart about it. - Elaborate: Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 4	- Explore: Omit the student choice research and only do the asthma research. Alternatively, skip the asthma research and allow for student choice. - Explain: Based on what you omitted in the Explore section, only do one cause and effect sphere interaction activity. - Elaborate: Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 5	- Omit all portions except for the Explore graduated cylinder, graphing activity, and development of a claim.
Lesson 6	- Keep as is.
Lesson 7	- Elaborate: Omit returning to the model. Students will revise the model again in Lesson 9.
Lesson 8	- Explain: Only have students draw their model and how energy is transferred. Omit drawing an actual wind turbine for comparision. - Elaborate: Read The Boy Who Harnessed the Wind or watch the video.
Lesson 9	- Keep as is.

Lesson 8: Summary

How can we use farms to harness wind energy?

Time: 3 days

Learning Target

Design, test, and share a wind turbine that can harness energy from the wind.

Summary

- In the previous lesson, students used Samsø as a case study to examine how humans can change their impacts on the environment.
- In this lesson, students engage in the engineering design cycle to develop a wind turbine that can be used to produce energy.
- **Students figure out that wind turbines can be used to harness energy from the wind, and transfer it to energy that can be used as a resource. They learn that they can use the engineering design cycle to develop and test solutions, and make improvements to these solutions using evidence and feedback from others.**
- In the next lesson, students analyze their biodigester data and obtain information in order to consider how farms can best make use of animal waste as a resource.

Building Towards

4-PS3-2.(4.PS3.B.1) | 3-5-ETS1- 2. (5.ETS1.B.1) | 3-5-ETS1- 3.

NGSS 3-Dimensions:

PS3.A: Definitions of Energy

PS3.B: Conservation of Energy and Energy Transfer

ETS1.A: Defining and Delimiting Engineering Problems

ETS1.B: Developing Possible Solutions

Developing and Using Models

Planning and Carrying Out Investigations

Energy and Matter

Lesson 8: Five E Quick View	
ENGAGE	Students share initial ideas about wind turbines and how they work.
EXPLORE	Students design and test a wind turbine with parts that act as a system to harness wind energy.
EXPLAIN	Students obtain and communicate information to see how others designed wind turbines to best harness wind energy. Students use models to explain how their design worked to harness energy from the wind.
ELABORATE	Students obtain information to inform how to redesign their wind turbines.
EVALUATE	Students evaluate their wind turbine designs using a rubric.

Lesson 8: Prep List

Inside mySci kit you will find:	Items you must supply:	Preparation:
The Boy Who Harnessed the Wind by William Kamkwamba and Bryan Mealer (8) 4x4x12" cardboard box (8) 12" dowels Ball of string 8 mini basket (8) 3-inch Styrofoam balls 32 popsicle sticks 24 sheets of cardstock 1 roll of duct tape	Coins or other weights for in the baskets (must be the same for all teams) Provide a scale or balance for this activity. A spring scale is recommended. Rocks for weighting the bottom of the box Electric fan Scissors Hot Glue Timer or stopwatch	Lesson 8 Student Journal pages or Printed Student Journals

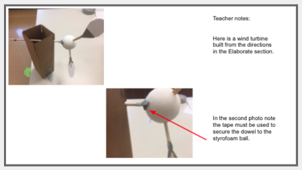
Literacy Connections	Remote Learning
Key Vocabulary **engineer:** a person who designs and builds things that solve a problem **prototype:** a first model or design of something Supplemental Reading Resources Energy for Life Catch the Breeze	Interactive & Mini Lesson Videos Hands-on at Home Suggestions Have students look at a ceiling or box fan at their house. Draw what the blades look like. How do they think the fan works? Alternatively, have students make a pinwheel. Draw a model to show how the pinwheel is able to move.

L8 – Five E Lesson Plan

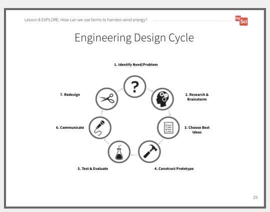
ENGAGE	
Students share initial ideas about wind turbines and how they work.	
	Begin the lesson by revisiting the Driving Question Board. Highlight questions connected to the learning goals of this lesson by calling attention to questions about **how farms might use renewable resources, like wind, for energy**. If no questions directly relate, use prompts to build on student questions, supporting them to think about the ways that farms might harness and use energy to do their work. Show students a video of wind turbines on farmland from Jeanne Norris (in Section 3 curriculum slides). Ask students: ‣ *What do you observe? Have you ever seen these before?* ‣ *One of the types of renewable energy we saw used on Samsø Island was wind energy. What do you observe from the video? (Students may notice that the wind turbines are on farms because they see plowed soil, farm buildings, etc.)* ‣ *What new questions do you have about wind energy?* Say to students: *Today's activity will support us in answering our question* (ex: **How can we use farms to harness wind energy?***). By answering this question, we will be able to design, test, and evaluate possible solutions that farmers can use to protect Earth's systems.*

EXPLORE

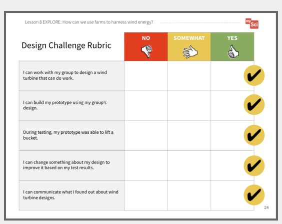
Students design and test a wind turbine with parts that act as a system to harness wind energy.



tutorial



Engineering Design Cycle Student Journal page



Design Challenge Rubric Student Journal page

Almost every mySci unit incorporates the engineering design cycle. At this point, students should be familiar with the cycle. If not, remind students that **engineers** are people who work to design and build solutions to problems we face. Say to students:

- *Engineers create new inventions that solve problems.*

Show students the Engineering Design Cycle Student Journal page and talk through each step. It is important for students to understand the cycle is a simplification of a complex process, and is not rigid. You won't necessarily complete steps 1-7, in that order. For example, you may redesign, and then retest, and communicate. Or, as part of your redesign, you may have to do more research.

Ask students:

- *What is the most important problem we've been exploring in this unit?* (We need energy to live our daily lives, but some sources of energy pollute the Earth more than others.)

Ask students:

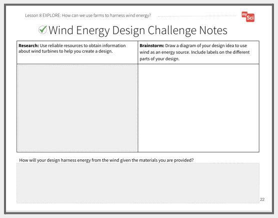
- *How could you use the design cycle to develop solutions, using wind turbines, that could help solve this problem?*

Next, show students the Design Challenge Rubric Student Journal page. Ask students to compare the rubric to the engineering design cycle.

- *How does each category of the rubric relate to the design cycle?.*

Divide your class into six groups. Tell students that they will take on the role of an engineer as they work in groups to design their own wind turbines.

Have a conversation about **criteria** (what the solution must do or be like - In this case the criteria is to design a wind turbine that transfers energy) and **constraints** (what you are limited by or cannot do – In this case the constraints are time and materials). This is a review from lesson 6.


Wind Energy Design Challenge Notes

Wind Energy Design Challenge Notes Student Journal pages

Attending to Equity: Engineering challenges are a great opportunity to show students how to "fail forward" and manage frustration. In order to allow students to bring their funds of knowledge to the table during engineering design challenges, allow them to help generate the list of criteria and constraints of the challenge. Here is a STEM Teaching Tool that discusses this topic.

Show them the materials they have available to them. Let them brainstorm in their groups how they could use the given materials to build a wind turbine that can harness energy from the wind.

Bring the class back together, and have students discuss how they think the materials could be used to build a wind turbine that meets the criteria. Say to students:

- *We need to be able to observe evidence that energy is being transferred using these materials. How might we use the bucket, string, and pennies to do that?* (If students do not say it, discuss with students how you can lift these materials using the wind turbine).
- *Is there any other evidence we could look for to know that energy is being transferred in our designs?* (Students may say: the blades might move, the wind turbine could make a sound)

There is an opportunity to review 4th grade physical science standards around energy transformations (mySci Unit 20, DCI PS3.A).

If students are struggling to see how these materials could form a wind turbine, display "Bucket Lift Drawing" (in Section 3 curriculum slides) and point out how the materials are used to make the turbine.

Have students access the Wind Energy Design Challenge Notes Student Journal pages. Individually, students research and brainstorm. Prior to this lesson, students have been provided with resources to research. In this lesson, students will be expected to research on their own. Review the guidelines for identifying reliable resources from lesson 4. Below are resources to support students if they are struggling:

- How to Make a Windmill
- Windmill
- Wind Energy Facts Video for Kids.
- Alliant Energy Whispering Willow Wind Farm 360-degree Tour

Based on their research, students should create an initial model of a wind turbine. Have students share their models with their groups. They should use evidence from their research to support their design ideas.

Use the following questions to help students discuss their individual models with one another, and determine what a group model would look like:

- How will this design solve the problem?

- Why do you think this design is the best choice?
- Would combining any of your ideas create a better solution?
- Why do you think that?

Based on their discussions, have groups choose the best ideas from their research and brainstorming. They should then draw a model of their group **prototype**. Remind students that it is important to label the parts of the design, the materials they will use for those parts, and how much material will be used.

After they show you their prototype, they can work together to construct it using the materials they have chosen.

Refer back to the Engineering Design Cycle Student Journal page. After students construct their prototype, they can test and evaluate it.

Explain to students that they must do a fair test. To do this, show them the fan that will be used for testing and the coins that will serve as the weight in the bucket.

Here is a teacher tutorial for the wind turbine activity.

Say to students:

- *The materials here are what everyone will be able to use for their wind turbines and they are the same for each group. Is there anything else that we should keep the same to make sure it is a fair test?*

Keep a list of their responses on the board.

Decide how you will measure your success as a class.

Example 1: Speed Challenge: Use a timer and measure how long it takes the bucket to reach the top of the windmill. (Use the same fan on the same setting, the wind turbine is the same distance from the fan, each team lifts the same amount of coins, each team lifts the same distance, teams have the same amount of time to work)

Example 2: Distance Challenge: Use a ruler to measure the maximum height the bucket reaches before it stops. (Use the same fan on the same setting, the wind turbine is the same distance from the fan, each team lifts the same amount of coins, teams have the same amount of time to work)

Example 3: Weight Challenge: See which wind turbine can lift the most pennies in the bucket. (Use the same fan on the same setting, the wind turbine is the same distance from the fan, each team lifts the same distance, teams have the same amount of time to work.)

If students miss any of these variables, prompt them. For example, if they miss “same distance from the fan” ask if it would be a “fair test” to place one wind turbine right next to the fan and one far away. As a class, determine the length of the string (40 cm is good), the weight of the bucket (or number/type of coins) and any other variables that would be controlled for a fair test.

EXPLAIN

Students obtain and communicate information to see how others designed wind turbines to best harness wind energy. Students use models to explain how their design worked to harness energy from the wind.

Formative Assessment

PS3.A: Definitions of Energy
Energy can be moved from place to place by moving objects or through sound, ~~light, or electric currents~~.

PS3.B: Conservation of Energy and Energy Transfer Energy is present whenever there are moving objects, sound, ~~light, or heat.~~ When objects collide, energy can be transferred from one object to another, thereby changing their

Once all groups are done testing, ask the groups to communicate their design and test results to the class. Ask students:

- *Why do you think it is important that we share our designs and results with each other?*
- *How will this help us improve our designs?*

Students can share the design they chose for their wind turbine, and why they thought it would be the most effective at transferring energy. After each group shares, provide space for other groups to give feedback. Tell students that they must provide at least one piece of feedback for each group. Make sure feedback is helpful, specific, and kind.

Examples of feedback students may provide:

Praise: Tell why you like it/why it is a strength.

Questions: Ask questions about components of the plan that are unclear.

Polish: Tell what is confusing/provide suggestions for improvement.

motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, ~~the air gets heated~~ and sound is produced.

Developing and Using Models
Develop a model using an example to describe a scientific principle.

Planning and Carrying Out Investigations
Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.

Energy and Matter
Energy can be transferred in various ways and between objects.

After seeing what students have come up with, have students obtain information about how wind turbines harness the wind to create electricity.

Show students the link to this slide: Wind Turbines from the US EPA. Focus their attention on the photo of a wind farm at the top of the slide.

To further help students explain how wind turbines use technology to harness wind energy and transform it into electricity, show this

Energy 101 video (3:16) from the Office of Energy Efficiency and Renewable Energy.

Here is a reading that can also help support this topic: How do wind turbines work? from Alliant Energy.

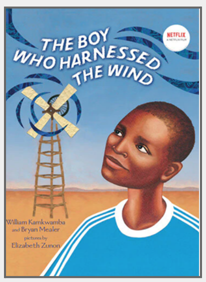
Be sure to focus students on the role of windmill technology and how this technology has evolved over time to meet the needs of humans (from windmills to wind turbines). It is not crucial that students understand the complexities of a wind turbine. Students should focus on the wind moving the blades, which causes energy to be produced in the form of electricity.

Have students use chart paper or whiteboards to create a chart. On one side of the chart students can draw a model of their design, and use their data and what they have learned to explain how energy is being transferred. For example, students may say energy was transferred from the fan to the blades. We know this because the blades and dowel rod began to move. They may also notice that the wind turbine makes noise as the wind moves the blades and the basket moves upward. This caused the bucket to lift. On the other side of the chart, students can draw an actual wind turbine, and show how energy transfer is occurring. Have students use the models to make comparisons. What are the limitations of their prototypes? How are they similar to an actual wind turbine? How are they different?

This activity is a chance to formatively assess students' understanding of the SEPs Planning and Carrying Out Investigations and Developing and Using Models , PS3.A and PS3.B, and CCC Energy and Matter. See the student journal answer key for an example. If students are struggling, develop a class comparison

ELABORATE

Students obtain information to inform how to redesign their wind turbines.



Read-Aloud Guide

Read the book, *The Boy Who Harnessed the Wind* by William Kamkwamba and Bryan Mealer.

Next show William Kamkwamba on Building a Windmill from William Kamkwamba via TED.

Ask students:

- *How many times do you think William had to design and redesign before he had a result he was satisfied with?*
- *How did he modify his design? Let's go back to the end of the story when William's turbine was successfully operating.*
- *How did he get feedback from others?* (The doubters clapped and cheered for him, one man told him "Well done!").

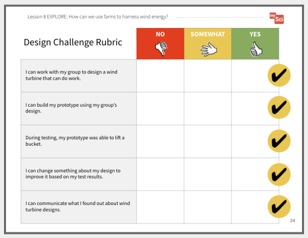
Say to students:

- *Now, you are going to have time to redesign your prototype and see if you can make a change to improve your wind turbine. Keep the following in mind when redesigning:*
    - What you observed in your initial design
    - What you observed in other groups' initial designs
    - The feedback you received from classmates
    - Information about how wind turbines work
    - Information from *The Boy Who Harnessed the Wind*

Time permitting, have students retest their designs, and communicate the results to their classmates. Did their designs improve? What evidence do they have to support this?

EVALUATE

Students evaluate their wind turbine designs using a rubric.



Lesson 8 EXPLORE: How can we use farms to harness wind energy?

Design Challenge Rubric	NO	SOMEWHAT	YES
I can work with my group to design a wind turbine that can do work.			
I can build my prototype using my group's design.			
During testing, my prototype was able to lift a bucket.			
I can change something about my design to improve it based on my test results.			
I can communicate what I found out about wind turbine designs.			

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Design Challenge Rubric Student Journal page

Formative Assessment

ETS1.A: Defining and Delimiting Engineering Problems

Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

Evaluate student's wind turbine designs outlined in the Wind Energy Design Challenge Notes Student Journal pages according to the Design Challenge Rubric S Student Journal page. Also allow students to self-evaluate using the rubric.

To support student sensemaking across the unit, orient students back to the DQB. Ask students:

- *What did we observe during today's activity?* (We observed how well different wind turbine designs addressed the problem we are trying to solve.) Record the activity and their observations.

Next, ask students:

- *What did we learn today? (Wind turbines transfer wind energy to electrical energy. We also learned about how engineering can be used to design solutions to problems. We learned how to use evidence from our tests and communication with others to revise our designs to better solve the problem.)*

Record their responses. If students need a reminder, they can reference their student journals.

Ask students:

- *How might this help us figure out how farmers can use resources wisely to protect Earth's systems? (Students may say that farms could use renewable resources such as the wind, the sun, or animal waste.)*

Next, ask students:

- *What new questions do you have?* Write student responses on the driving question board. (They may have new questions, such as:

ETS1.B: Developing Possible Solutions Research on a problem should be carried out before beginning to design a solution. Testing~~ a solutio~~n ~~involves investigating how well it performs under a range of likely conditions.~~ At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. **Planning and Carrying Out Investigations** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	○ *How many wind turbines would you need to power a farm? How much space do wind turbines take up on a farm?* ○ *What do we use for energy when it is not windy?*) Do not provide these questions for students, instead help them start thinking about these ideas by focusing their attention to what we might need to consider about wind turbines and energy. Have students place their questions into existing categories, or create new categories.